

Section 10. Horseshoe Crabs

Background

Horseshoe crabs (*Limulus polyphemus*) are benthic organisms found in both estuarine and continental shelf habitats. They are not true crabs, but are more closely related to spiders and scorpions. *Limulus* ranges from the Yucatan peninsula to northern Maine, but is most commonly found in the mid-Atlantic region between Virginia and New Jersey. In the Chesapeake Bay, horseshoe crabs are present year-round near the mouth of the Bay and have been documented in the Eastern Bay, Rappahannock, Miles, Chester and Choptank rivers. Adult horseshoe crabs feed primarily on marine worms and shellfish, including razor clams and soft-shelled clams. Because they lack jaws, horseshoe crabs use the spiny bases of their legs to crush and grind their food and to push it into their mouths. Spawning has been observed on sandy beaches throughout the Chesapeake Bay and appears to be limited to areas with salinities of 8ppt and greater.

Horseshoe crabs can tolerate a wide range of temperatures and have distinct physiological processes that enable them to survive low oxygen environments. Adult horseshoe crabs have been found burrowed into anoxic muds and intertidal flats at low tide, but spawning adults will avoid anaerobic sediments in beach areas. They can move out of the water during spawning and survive extended periods of time out of the water if their book gills are kept moist. Since horseshoe crabs undertake inshore and offshore migrations they are particularly affected by environmental degradations in both estuarine and oceanic habitats. Activities that alter the protected sandy beaches that horseshoe crabs use for spawning, such as creating bulkheads, placing riprap, replenishing beaches, creating landfills and revetments activities, ultimately will have a negative impact on the horseshoe crab population.

Horseshoe crabs play an important ecological role in the food web. Adults are an important component in the diet of juvenile loggerhead turtles, a threatened species that uses the Chesapeake Bay as a summer nursery area. Horseshoe crab eggs also provide seasonal food to several finfish species and several shorebird species eat the eggs to replenish their fat supply on their migrations to Canadian breeding grounds. The Delaware Bay is an epicenter for this phenomenon with less importance on Maryland's Atlantic coastal areas. It's estimated that migratory shorebirds can consume nearly 320 tons of eggs annually. It is believed that a decrease in the horseshoe crab population would be detrimental to migratory shorebirds.

Not only are horseshoe crabs important in the food web, they also support a bait fishery for eels and conch. They are also very important to the biomedical industry. Horseshoe crab blood is used to create *Limulus amoebocyte lysate* (LAL) which is used for the detection of gram negative bacteria in a screening process for all injectable drugs for humans.

Chesapeake Bay FMP

A Chesapeake Bay and Atlantic Coast Horseshoe Crab Fishery Management Plan was completed in December 1994. It recognized the unique role that horseshoe crabs have in the ecology of the Bay and Atlantic coast, its economic value as a fishery and its importance to humans. Maryland and Virginia were ahead of the coastal states in implementing seasonal

closures to protect the spawning population; protecting beach habitat; and requiring fishing reports. The Chesapeake Bay FMP identifies the need to obtain better biological data in order to assess the status of the stock. A synopsis of the plan's strategies and action are found on Table 10.1.

Atlantic Coast FMP

The ASMFC's Interstate Fishery Management Plan for Horseshoe Crab (December 1998) and Addendum I to the Fishery Management Plan for Horseshoe Crab (April 2000) established a state-by-state cap on horseshoe crab bait landings at 25 percent below reference period landings. Once a state's cap is reached the horseshoe crab bait fishery in that state would be closed. This measure was the primary method of reducing harvest. As one of the states in the epicenter of horseshoe crab abundance, Maryland chose to implement a more restrictive harvest reduction strategy. The coastal plan also established a no harvest reserve area at the mouth of the Delaware Bay and was formally implemented in 2001. All coastal states were required to begin a monitoring and research program for horseshoe crabs because there was a significant lack of data by which to assess the status of the stock. States are also required to complete an annual compliance report (Appendix 6).

Addendum II to the Interstate Fishery Management Plan for Horseshoe Crab (May 2001) to the HSC FMP established a mechanism for the responsible and voluntary transfer of quota between states in order to alleviate bait supply problems to states with low horseshoe crab populations. This measure was necessary because once harvest from the major mid-Atlantic states (NJ, DE & MD) was more restricted, instead of the total coastal catch decreasing, neighboring states increased their harvest because of market demand. This measure ensured that the original intent of a 25% reduction in total coast wide harvest was attainable.

Addendum III to the Interstate Fishery Management Plan for Horseshoe Crab (May 2004) further reduced commercial harvest of horseshoe crabs for bait in and around the Delaware Bay due to the horseshoe crab being a major dietary component for migratory shorebirds including the *rufa* red knot (*Calidris canutus*), whose population has decreased since the 1980s and utilizes the Delaware Bay area as a major stop over point. New Jersey and Delaware are restricted from harvesting greater than 150,000 horseshoe crabs each per year. Maryland is restricted from harvesting greater than its 2001 landings (170,653 horseshoe crabs) per year.

Stock Status

When the ASMFC FMP was developed in 1998, it was apparent how inadequate the information was on the horseshoe crab stock along the coast. There wasn't enough information available to establish biological reference points (BRPs), estimate recruitment or measure fishing mortality (F). A conservative, risk-averse approach was taken because of the possibility of localized population decreases, an apparent increase in catch and effort, the long maturation time (9 to 12 years), susceptibility of the stock to be harvested while spawning, and the need to protect horseshoe crab eggs as a food source for migratory shorebirds. The 1998 FMP recommended measures to collect important biological and harvest data.

In 2004, a new stock assessment was undertaken. Although improvements have been made in obtaining data, the ability to accurately assess the horseshoe crab population is still limited. Due to the limited data, a trend analysis was utilized for an assessment. Trend analysis provides no biological reference points but it tests for a significant increase or decrease in population indices over all or part of the data time series. Trend analysis is commonly used in fisheries cases where datasets are limited and biological reference points are not available. The results of the stock assessment infer the following findings and recommendations:

- a) The coastwide horseshoe crab population is subdivided into regional/local populations.
- b) Horseshoe crab abundance trends varied regionally/sub-regionally.

- Abundance measures in the Delaware Bay declined significantly during the 1990s. Declines from the late 1980s to early 1990s appear to be steeper than declines in recent years. However, the redesigned Delaware Bay spawning survey showed no significant change in relative abundance from 1999 to 2002, with change in excess of 7 to 8% per year (28% decline or 36% increase over 4 years) being unlikely (ASMFC 2003).

- Overall, the analysis found that even though there are signals that declines in some regions have abated, it is still unclear if spawning biomass is sufficient to sustain the population for the long term under current harvest thresholds and it is unclear if spawning biomass is sufficient to sustain dependent wildlife.

- c) Intermediate assessment approaches could provide estimates on harvest level and sustainability.

- d) Horseshoe crab and shorebird assessments are managed separately and should be assessed jointly in order to meet the requirements of the ASMFC horseshoe crab FMP.

- e) Inherent variability in the data and power analyses on available data indicate that, for the majority of horseshoe crab indices, detecting small changes in population size would require 10 to 15 years of data. Over the short term, these indices would only be able to identify a catastrophic decline in the horseshoe crab population. Coastal states should continue to monitor the horseshoe resource and collect biological and fishery data.

Fishery Statistics

Horseshoe crabs were once primarily harvested for use in poultry and livestock food and fertilizers. Currently horseshoe crabs, most often females with eggs, are commercially harvested for use as eel, conch, and catfish bait along the Atlantic coast. Commercial harvest from the northeastern Atlantic coast has ranged between 10,000 pounds and 2 million pounds over the last 30 years. Since 1988, commercial landings have averaged 950,000 pounds. The commercial statistics are based on a horseshoe crab's average weight of 4 pounds. Reported dockside value from the northeastern Atlantic coast fishery statistics probably underestimates the catch of horseshoe crabs because the sale of crabs for bait is often arranged between private individuals rather than through centralized dealers.

In recent years horseshoe crabs also have been important in medical research. Scientists have used the crabs in ophthalmological research, for surgical sutures, in the development of

wound dressings and in the detection of bacteria in drugs. The discovery of *Limulus amoebocyte lysate* (LAL), a clotting agent found in horseshoe crab blood, has made it possible to detect human pathogens such as spinal meningitis and gonorrhea in patients and in drugs. Any drug produced by a pharmaceutical company must pass a test using LAL, which manufacturing companies obtain by bleeding large horseshoe crabs. An estimated 200,000 crabs are used annually in medical research. These horseshoe crabs must be returned to the environment where they were caught. Although the adults are released alive, they experience a 10% mortality due to capture and being bled. Horseshoe crabs caught for medical use are an additional source of mortality and are not included in the commercial catch statistics.

Maryland has been responsible for harvesting between 23% and 78% of the total commercial catch of horseshoe crabs from the northeastern Atlantic coast since 1980. In Virginia, the commercial harvest of horseshoe crabs averaged 190,000 pounds between 1980 and 1988. Since the ban on trawling within state waters was implemented in 1989, horseshoe crab landings have decreased significantly with landings averaging 22,000 pounds. In 2004, Maryland's commercial harvest of horseshoe crabs was reported as 520,908 pounds and Virginia's commercial harvest has been reported as 223,718 pounds (Figure 10.1).

Summary

The ability to accurately estimate the horseshoe crab population within the Bay does not exist and more detailed monitoring would be required. However, the current trend analysis indicates that some horseshoe crab populations are no longer decreasing or are currently stable. A greater understanding of the interactions between horseshoe crabs and migratory shorebirds is required in order to better understand horseshoe crab population dynamics.

References

Atlantic States Marine Fisheries Commission. 2004. Addendum III to the Interstate Fishery Management Plan for Horseshoe Crab May 2004.

Atlantic States Marine Fisheries Commission. 2004. Horseshoe Crab 2004 Stock Assessment Report February 2004.

Atlantic States Marine Fisheries Commission. 2001. Addendum II to the Interstate Fishery Management Plan for Horseshoe Crab May 2001.

Atlantic States Marine Fisheries Commission. 2000. Addendum I to the Fishery Management Plan for Horseshoe Crab April 2000.

Atlantic States Marine Fisheries Commission. 1998. Interstate Fishery Management Plan for Horseshoe Crab December 1998.

Chesapeake Bay Program. December 1994. Chesapeake Bay and Atlantic Coast Horseshoe Crab Fishery Management Plan – Agreement Commitment Report 1994.

Figure 10.1 Commercial Harvest of Horseshoe Crabs from Maryland and Virginia, 1975-2004

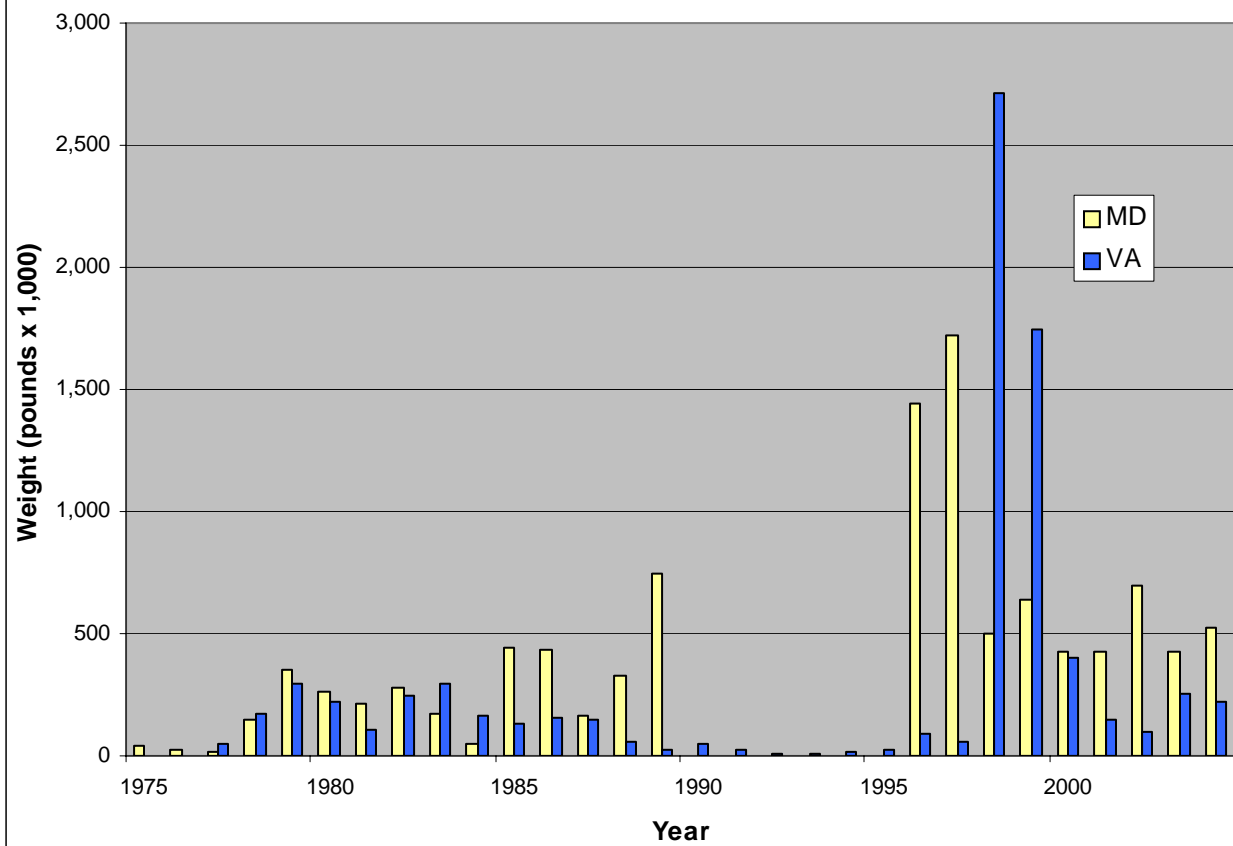


Table 10.1. 1994 Chesapeake Bay Program Horseshoe Crab Implementation Table (updated 2005)

Problem Area	Action	Date	Comments
1. Ecological Value	1.1. Maryland and Virginia will prohibit the hand collection of horseshoe crabs from beaches during the peak time of shorebird migration, May 1-June 7.	1996 Continue	MD (Action to prohibit hand collection of HSCs between May 1 and June 7 was changed based on MD spawning survey data. In January, 1996, MD adopted measures to restrict the hand collection of HSC between April 1 and June 30 to Monday and Thursday only.
		Open	(VA) Only restriction on hand collection is the requirement of a \$15 HSC hand harvester license. 5 HSCs/person may be harvested for personal use without a license
	1.2a Maryland will prohibit the scraping, trawling or dredging of horseshoe crabs between May 1 and June 7 within the Chesapeake Bay, coastal bay areas, and 1 mile of the Atlantic Coast.	1996 Continue	The time period recommended to prohibit the scraping, trawling, and dredging of HSCs with the Chesapeake Bay, coastal bay areas, and within 1 mile of the Atlantic coast was changed from May 1 and June 7 to April 1 and June 30 based upon MD spawning survey data.
	1.2b Virginia will continue it's ban on trawling within state waters.	Continue	Commerical harvest based on coastwide quota system. MD has implemented additional restrictions based on ASMFC Addendum III.
	1.3 Virginia will prohibit a directed horseshoe crab fishery between May 1 and June 7, continue mandatory reporting in the conch dredge fishery and monitor bycatch	Open	An ASMFC HSC FMP was adopted in 1998 and since than additional harvest restrictions have been implemented. An amendment to the CBP FMP has been recommended.
2. Stock Status	2.1 Maryland and Virginia will coordinate and implement a horseshoe crab spawning stock census in Chesapeake Bay, coastal bays, and along the Atlantic coast	1994 2000	An annual spawning stock survey was initiated from 1994-2000 in MD. The Delaware spawning survey provides data on assessing the status of the spawning population.

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Problem Area	Action	Date	Comments
	2.2 Maryland and Virginia will promote and encourage research on horseshoe crab estimates of population abundance, age and size composition, mortality estimates and migration	1994 continue	Participate in the annual HSC meeting of regional biologists and managers. Partially funded a project at University of Maryland Eastern Shore to determine if spawning stock survey can be used to provide statistically significant index of abundance
			Collected CPUE data from MD's offshore and coastal bay trawl survey, and blue crab summer trawl survey within the Chesapeake Bay.
			Collected sex data from MD's spawning beach survey
			Initiated a tagging program in 1995 to determine migratory patterns, identify stocks, and increase our understanding of the HSCs spawning behavior. USFWS currently directs the effort.
3. Fishery	3.1a Maryland will require horseshoe crab harvesters to provide monthly reports on the size of harvest, area of collection, gear usage, and any other information the Department of Natural Resources deems necessary	1996 Continue	Implemented on January 29 th , 1996. Permit system currently required and used to monitor commercial harvest. MD has a 750,000 lbs commercial quota. MD has a sex ratio limit of 1:1 in any one day to avoid excessive harvest of females.
	3.1b Maryland will determine if a special permit to harvest horseshoe crabs is necessary after evaluating the new federal reporting system and the results of the monthly reports	Open	MD requires a special HSC permit to land HSCs.
	3.2 Virginia will continue their mandatory reporting procedures.	1993 Continue	Implemented in January of 1993. VA has a commercial quota based on coastal reference period.
	3.3 Maryland and Virginia will survey American eel harvesters and their use of horseshoe crabs by sex for bait.	2000	No longer an issue. Both eels and horseshoe crabs are managed through an ASMFC coastal FMP.
4. Habitat	4.1 Maryland and Virginia will initiate a study to delineate the geographic distribution of horseshoe crab spawning habitat in the Bay and coastal bays if funding is available	1994 Continue	A HSC hotline and spawning beach survey was developed in 1994 to delineate spawning habitat in Maryland. The survey is available through the DNR website. VA has also established a hotline.
	4.2 The jurisdictions will promote research to define the water quality requirements for horseshoe crabs.	1994 Continue	

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Problem Area	Action	Date	Comments
	The jurisdictions will continue to work with the Chesapeake Bay Program, the Coastal Bay Initiative, and water quality improvement goals for the Bay and coastal areas.	Continue	The Chesapeake 2000 agreement commits to improving habitat and water quality for living resources in the Bay.

ASMFC= Atlantic States Marine Fisheries Commission

FMP= Fishery Management Plan

USFWS= US Fish and Wildlife Service